

- IV. "On the Organisation of the Fossil Plants of the Coal-measures. *Heterangium Tiliacoides* (Will.) and *Kaloxylon Hookeri*." By Professor W. C. WILLIAMSON, LL.D., F.R.S., Professor of Botany in the Owens College and in the Victoria University. Received December 1, 1886.

(Abstract.)

Several years ago the author discovered the stems and branches of a remarkable plant in the Carboniferous beds at Burntisland, which he described in the volume of the 'Philosophical Transactions' for 1873, under the name of *Heterangium Grievii*. This plant displayed a central axis, in which was combined a curious mixture of cells and vessels. These were surrounded by a vascular zone, with medullary rays, evidently a product of an investing cambium layer. Outside this exogenous growth were a complex series of cortical layers, with various arrangements of vascular bundles going off to supply lateral appendages. The indefatigable industry of my valuable auxiliaries, William Cash, Esq., and Mr. Binns, of Halifax, have supplied a series of specimens which the author soon found to be a new species of *Heterangium*, to which he gives the name of *Heterangium Tiliacoides*. Whilst the plant exhibits all the features of interest seen in *H. Grievii*, it has others peculiar to itself. Its central axis corresponds closely with that of *H. Grievii*. Its exogenous vascular or zylem zone is more fully developed than in the older species, but the most striking features are seen in new structures external to and developed by what has been a cambial zone. The zylem consists of groups of vascular laminae, the inner ends of each of which groups so converge as to separate the vascular ring into a series of distinct bundles. These are not only separated from each other by primary medullary rays, but as each of these latter passes outwards towards the cortex, it rapidly expands laterally, assuming, in transverse sections, a trumpet-shaped contour. These are in fact true primary phloem rays, as fine as those seen in the shoots of the Lime tree; hence the specific name of *Tiliacoides* given to the plant by the author.

Between these large phloem rays are clusters of phloem, the radial diameter of each of which is co-extensive with the zylem part of the bundle to which it belongs. Each of the zylem-bundles is subdivided into minor groups of two or three vascular laminae, separated by secondary medullary rays, each of which latter can be traced as secondary phloem rays passing radially outwards through the phloem portion of each bundle. The vessels seen both in the vasculo-medullary axis and in the exogenous zone are chiefly furnished with bordered

pits, not confined, as in Conifers, to the sides of the vessels in contact with the medullary rays, but covering their entire circumference.

On examining tangential and radial sections of the phloem, it is found to contain numerous long narrow tubes, but which cannot be absolutely identified with either sieve tubes or with sclerous fibres. In the outer bark numerous flat plates of coarse sclerous parenchyma pass horizontally outwards. This feature is equally characteristic of *Heterangium Grievii*. Various forms of lateral outgrowths are also described.

Further observations are recorded on the structure of *Kaloxylon Hookeri*, also originally described by the author from specimens obtained from collieries near Oldham, in 'Phil. Trans.,' vol. 166 (Part I, 1876). These specimens, though revealing the elegant arrangements, especially of its vascular structures, to which the plant owes its name, did not fully reveal the true structure of its cortex. But soon after the publication of the memoir referred to, the author obtained from Halifax beautiful examples in which this defect was remedied. These new specimens exhibited within a remarkable epidermal layer, a thick cortex, always abounding in narrow vertically elongated tubes, which appear to have been either gum or resin canals. In some examples these are crowded together in remarkable numbers. But the Halifax specimens exhibited other peculiarities. In some of them the peripheral end of each of the five or six radiating vascular wedges, which are so characteristic of the plant, is furnished with a true phloem element. In the larger proportion of the Halifax specimens the radiating exogenous extensions of the central vascular axis are wholly wanting, and, whilst in most of the specimens which possess these exogenous growths no cellular parenchyma appears amongst the vessels of that central axis, specimens are described which display a gradual development of such tissue in that position. In some cases its amount almost equals the area occupied by the medullary vascular bundles. Some of the latter examples give off rootlets from the exterior of the central vasculo-cellular axis, which pass directly outwards through the bark. A further series of specimens is described, each of which contains vascular bundles, of which the transverse section is quadrangular, closely resembling the tetrarch bundles of many roots. Tracing these bundles downwards through a number of examples which diminish in size until very minute ones are reached, we find evidence that these bundles developed centrifugally instead of centripetally. Nevertheless the author inclines to the belief that these objects are true rootlets.

After pointing out the probability that the *Lyginodendron Oldhamium* previously described by him is, notwithstanding its exogenous mode of growth, a fern, of which *Rachiopteris aspera* was the foliage, the author states that Mr. Kidston has supplied him with structureless specimens

preserved in shale, of *Sphenopteris elegans*, which display regular transverse ridges crossing their stems and branches, which seem to have been caused by the presence of bands of some hard substance, corresponding exactly with those seen in the outer bark of both the Heterangiums. These, at all events, are the only examples of fossil Carboniferous plants, in which structures comparable with those of the Heterangium stems have been discovered. It is not without significance that *H. Grievii* has not only been found in the Westphalian deposits of Pith Vollmond, but a German locality has furnished Professor von Weiss, of Berlin, with specimens of *Sphenopteris elegans*, having the same kind of bark as those found in Scotland. The author suggests that the Heterangiums may possibly have been ancestral forms, having exogenous stems and fern-like foliage, which may have bequeathed the former features to some of the modern Cycads, and the latter to the Ferns, the living *Stangeria* having retained some of the features of both.

Presents, January 6, 1887.

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